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INTERNATIONAL STANDARD PROJECTIONS FOR METEOROLOGICAL CHARTS

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At Salzburg, Austria, on September 16, 1937, the Commission on Projections for Meteorological Charts, as it is now officially designated, adopted nine resolutions, eight of which contain recommendations regarding meteorological charts. The other resolution was a decision to change the name of the Commission; it had previously been known as the "Commission on Map Projections." Later, the eight resolutions dealing with meteorological charts, after slight modifications, were adopted by the International Meteorological Committee. It is the purpose of this article to give briefly the history of action in the International Meteorological Organization on projections and scales of charts, to state the objectives of the eight resolutions of Salzburg, and to discuss briefly the projections selected.

HISTORICAL

Organized efforts to secure uniformity in the projections and scales of meteorological charts are of comparatively recent origin. Although the synoptic chart was made practical by the invention of the electric telegraph, it was not until the development of radio communication that international exchanges of weather information made it possible to extend the charts over the oceans and to other continents. As one result of the extension, map projections that had been used for charting small areas proved in some cases to be unsuitable for large areas, hence additional projections were employed. Thus it came about that different meteorological services that began to draw weather maps extending over the same region used different map projections for that region. One example, which is by no means the outstanding one, is the daily chart of the Northern Hemisphere; both the stereographic and the equidistant azimuthal projections came into use for this purpose.

One of the first meteorologists to recognize the growing need for uniformity was V. Bjerknes. Nearly 20 years ago he declared that numerous and important problems might be solved with the aid of observations already assembled in the archives of different bureaus, but that the difficulties in making these observations serve a special purpose were unsurmountable for the individual scholar. He added that, in particular, the synoptic charts representing the momentary states of the atmosphere over large areas of the earth, in all the necessary details and exactitude, were excessively difficult to assemble. His proposal was that there be entered at the central bureau of each country, on the appropriate maps, all the available observations taken in that country and that there be employed, by the different bureaus, maps that may be simply superimposed or juxtaposed.

Bjerknes' proposal was made at the International Conference in Paris in 1919 and was published as an appendix to the report of the meeting.[1] His views were more fully expressed in 1920 in connection with geophysical charts in general.[2] His proposals were adopted in Resolution 34 of the Eleventh Ordinary Meeting in London in 1921.[3] This resolution specified three conformal projections, one for the polar regions on a plane cutting at 75°, another for middle latitudes on a cone intersecting at 30° and 60°, and a third for the equatorial regions on a cylinder cutting at 15°; the scales were 1:2,500,000; 1:5,000,000; 1:10,000,000; and 1:20,000,000, with recommendation that the scale 1:10,000,000 be used whenever possible.

At a meeting of the Commission on Maritime Meteorology at Copenhagen in 1929, special maps for the Atlantic Ocean and the Northern Hemisphere were discussed and the following were recommended: For the Atlantic, a monoconic projection with intersections at 30° and 60° latitude and, for the Northern Hemisphere, a circumpolar map on an orthogonal projection with the plane through 60° latitude. This proposal was adopted as Resolution 22.[4] As the result of this resolution there came into use a North Atlantic map on a conic projection with standard parallels at 30° and 60° and scale 1:20,000,000, also a Northern Hemisphere map on an equidistant azimuthal projection with standard parallel at 60° and scale 1:30,000,000. These two scales were recommended at that time by the Maritime Commission as the ones best suited for these purposes.[5]

At the same meeting (1929), Resolution 97 was adopted as follows:

> 1. The subcommission recognizes the great importance to all branches of meteorological work of finding the best system of maps on the principles laid down in Resolution 34, paragraph 1, of the London Meeting 1921. It recommends for this purpose the appointment of a joint subcommission composed of members from all the commissions interested.
> 2. Until the joint subcommission has completed its work it is recommended that services should adhere as far as possible to the whole Resolution 34 of the London Meeting, 1921.

The joint subcommission authorized by this resolution was nominated in May 1935, with 6 members, one from each of the following Commissions: Maritime Meteorology, Synoptic Weather Information, Investigation of the Upper Air, Terrestrial Magnetism and Electricity, Reseau Mondial and Polar Meteorology, Climatology.

At Warsaw in 1935 this joint subcommission recommended that Resolution 34 of London be altered so that

[1] Great Britain Meteorological Office. Report of the Proceedings of the Fourth International Conference of Directors of Meteorological Institutes and Observatories and of the International Meteorological Committee, Paris, 1919. M. O. 239, appendix I, pp. 32, 33. London, 1921.

[2] Bjerknes, V. Sur les projections et les échelles à choisir pour les cartes géophysiques. *Geografiska Annaler*, Vol. I, pp. 1–12, 1920.

[3] Great Britain Meteorological Office. Report of the Eleventh Ordinary Meeting, London, 1921. M. O. 248, pp. 29, 30. London, 1922.

[4] International Meteorological Organization. Procès-verbaux des séances de la conférence internationale des directeurs du comité météorologique internationale et de diverses commissions à Copenhague, septembre 1929. pp. 31, 32. Utrecht, 1929.

[5] *Ibid.*, p. 220.

the plane of the polar charts cut at 50° instead of 75°, and the cylinder for equatorial charts cut at 25° instead of 15°.[6] Hope was expressed that a continued study of the problem would lead to the adoption of 2 or 3 types of world maps suitable for general use.

In Resolution 114 at Warsaw the joint subcommission was changed to an independent commission. The President of the International Meteorological Organization then appointed W. R. Gregg president of the new commission.

In reviewing the work of the organization on map projections up to that time (1935), it will be noted that the provisions of the original London resolution had been changed with regard to the standard parallels of polar and equatorial projections, and also by the addition of a scale of 1:30,000,000. Furthermore, an equidistant azimuthal projection had come into use for the Northern Hemisphere, although this projection is not strictly conformal but is a sort of compromise between conformality and equivalence.

THE SALZBURG RESOLUTIONS

At the meeting of the Commission in Salzburg on September 16, 1937, the following resolutions were drawn up and were later adopted by the International Meteorological Committee:

RESOLUTION I: The Commission decides that its name be changed to "Commission on Projections for Meteorological Charts."

RESOLUTION II: The Commission recommends that three conformal (orthomorphic) projections be used for synoptic meteorology, as follows:

(*a*) The stereographic projection for the polar regions on a plane cutting the sphere at 60°.

(*b*) The Lambert conformal conic projection for middle latitudes, the cone cutting the sphere at 30° and 60°.

(*c*) Mercator's projection for the equatorial regions, with true scale at 22½°.

RESOLUTION III: The Commission decides that the stereographic polar projection may be extended to cover a hemisphere; that Lambert's conformal conic projection may be extended poleward from 60° or equatorward from 30° as may be necessary to produce a continuous chart, and that Mercator's projection may be extended to make a chart of the world or of any large part of the world when the region of primary interest is in the equatorial zone.

RESOLUTION IV: The Commission reports that it has been unable to find any conformal projection that will provide a wholly satisfactory chart of the world in one section for synoptic meteorology; that Mercator's projection is the nearest approach, but its distortions in high latitudes are serious; that two stereographic charts of the hemisphere placed side by side may be used as a meteorological chart of the world in two sections.

RESOLUTION V: The Commission recommends that the following scales be used for manuscript (working) charts:

(*a*) For large-area charts of the world, a hemisphere, or a large part of a hemisphere, the scales along the standard parallels should be:

1 : 20,000,000 (large area),
1 : 30,000,000 (a hemisphere),
1 : 40,000,000 (world).

(*b*) For charts of a continent or an ocean or considerable parts of either or both on a single chart, the scales along the standard parallels should be:

1 : 7,500,000,
1 : 10,000,000,
1 : 15,000,000.

(*c*) For detailed charts the scales should be:

1 : 1,000,000,
1 : 2,500,000,
1 : 5,000,000.

(*d*) That preference be given whenever possible to the following scales:

For the hemisphere, 1 : 30,000,000.
For a large area, 1 : 20,000,000.
For a large continent or ocean, 1: 10,000,000.
For detailed charts, 1 : 5,000,000.

RESOLUTION VI: The Commission recommends that the directors of meteorological services adopt one of the projections and scales mentioned in Resolution No. V for each chart used for synoptic meteorology, whether the charts are prepared in single copies by hand (manuscript) or in quantities for distribution and exchange (printed or duplicated). If this is not possible owing to costs and other factors, that whenever a change becomes necessary, effort will be made to utilize projections and scales from the international standards adopted by this Commission.

RESOLUTION VII: The Commission recommends that every chart for meteorological purposes have printed on its face the name of the projection and the scale at the standard parallel, 22½°, 30°, or 60° (both 30° and 60° in the case of the conic projection); and that the scales be also printed on the chart at different latitudes.

RESOLUTION VIII: The Commission suggests that, in principle, the standard projections for climatological uses should be equal-area; and that when special charts for climatology are required, the following are suggested:

(*a*) An equal-area azimuthal projection of the polar regions, on a plane cutting the sphere at 60°.

(*b*) An equal-area conic projection of middle latitudes with intersections at 30° and 60°.

(*c*) An equal-area cylindrical projection of the equatorial regions, the cylinder cutting the sphere at 22½°.

Any of these three projections may be extended as required to produce a continuous map of the region to be charted.

RESOLUTION IX: The Commission recommends that, whenever a meteorological service changes the projection or scale of any of its existing charts or adopts an additional chart, the director of the Service shall send to the president of the Commission on Projections for Meteorological Charts 30 copies of the chart in order that the members of the Commission may be informed regarding all charts in regular use.

The Commission for Synoptic Weather Information adopted a resolution formulated in the Symbols Subcommission, from which the following is quoted:

The Commission emphasizes the importance of making universal use of the Warsaw station model and symbols and the advantages of the use of synoptic charts on the scale 1 : 10^7. The Commission also recommends that services which find difficulty in plotting should communicate with the Chairman of the Symbols Subcommission with regard to the technical methods of giving effect to this recommendation.

COMMENTS ON THE SALZBURG RESOLUTIONS

A stereographic map is obtained by a perspective projection of a sphere onto a plane, from a point on the surface of the sphere diametrically opposite the point at the center of the map; e. g., in a projection of the Northern Hemisphere with the North Pole at the center, the point of projection is at the South Pole. When the ellipticity of the earth is taken into account, the ellipsoid is first mapped conformally upon a sphere, and the sphere then projected stereographically onto a plane. The parallels of latitude are concentric circles, and the meridians are radii of these circles. It is the only azimuthal projection in which there is no angular distortion and in which every circle is projected as a circle (fig. 1). It is conformal, that is, at each point the scale is the same in all directions—in particular along both the meridians and the parallels—so that length and breadth are increased in the same ratio; and hence angles, and the true shapes of *small* areas, are preserved.[7] The scale varies with latitude, but is constant along parallels.

The method of projecting the sphere is shown in figure 2 (the position of the plane upon which the projection is made is immaterial, merely changing the scales at all latitudes in a common ratio). In the preliminary conformal projection of the ellipsoid onto a sphere, the parallel of latitude ϕ on the ellipsoidal earth projects into a parallel on the sphere at a different latitude ϕ' which is called the isometric or conformal latitude; to an accuracy sufficient for the present purpose $\phi-\phi'=[2.8421554]$

[6] International Meteorological Organization. Conférence des directeurs à Varsovie, 6-13 septembre, 1935. Tome I, p. 104. Leyde, 1936.

[7] The stereographic polar projection is used by the U. S. Weather Bureau for its Northern Hemisphere chart.

sin $2\phi-[9.98969-10]$ sin 4ϕ seconds, on the International Ellipsoid. The stereographic polar projection is easily constructed either graphically as shown in figure 2 or by computing the radii Np, Nq, . . . of the parallels of latitude on the map. When the earth is considered as a sphere, the

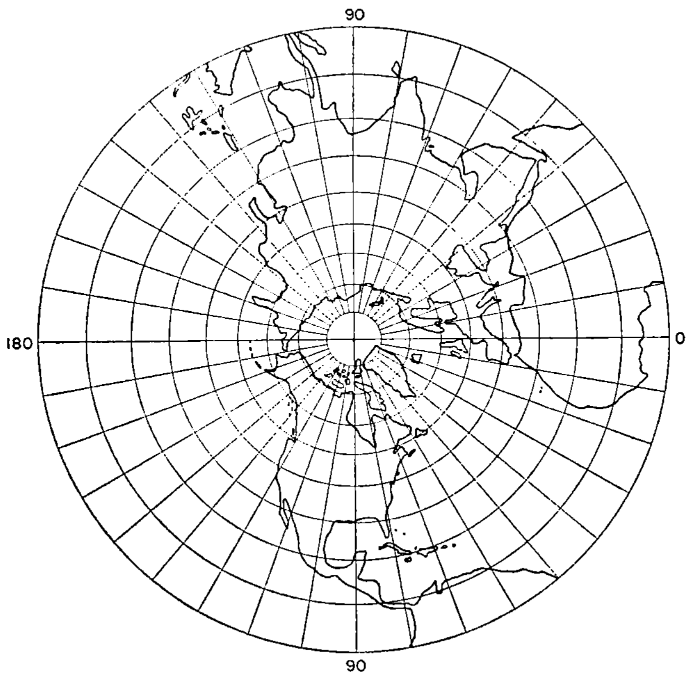

FIGURE 1.—Stereographic polar projection of the Northern Hemisphere.

arcs NP, NQ, . . . are taken equal to the polar distances p of the parallels that are being mapped, and the radii are obviously $r=c \tan \frac{p}{2}$ where c is the constant determined by the standard scale; when the ellipticity of the earth is taken

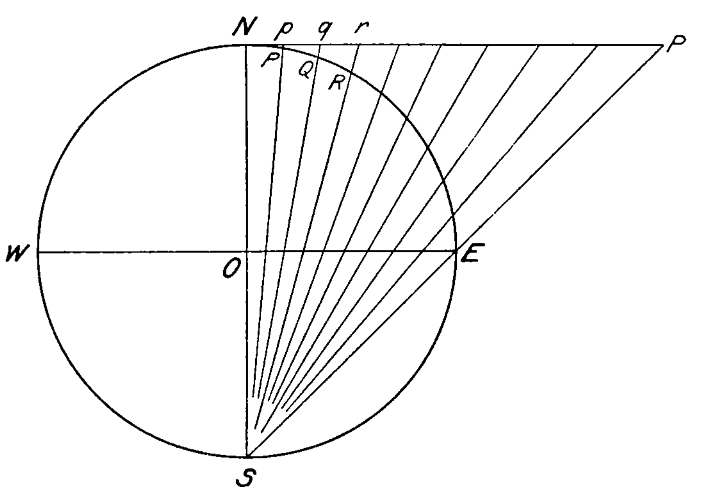

FIGURE 2.—Construction of the stereographic polar projection with the point of projection at the south pole. $NESW$, plane of meridian; $Npqr$, intersection of plane $NESW$ with mapping plane tangent at north pole N.

into account, the arcs NP, NQ, . . . are taken equal to the isometric colatitudes z obtained from ϕ, and the radius of the parallel of ϕ on the map is $r=k \tan \frac{z}{2}$. The meridian of longitude λ intersects the prime meridian on the map at the true angle λ.

The stereographic projection with one of the poles in the center has increasing exaggeration of areas toward the equator. When Northern Hemisphere charts were first coming into use, there were relatively few reports from the tropics, hence the exaggeration of area of the stereographic projection in that region was objectionable. Relatively, much more charting space was needed at that time for the numerous reports in middle latitudes. For this reason, the equidistant azimuthal projection of the hemisphere was preferred. In recent years there has been an increase in the number of reports from land stations and ships in the tropics, hence the stereographic projection is now considered preferable to the equidistant projection for synoptic

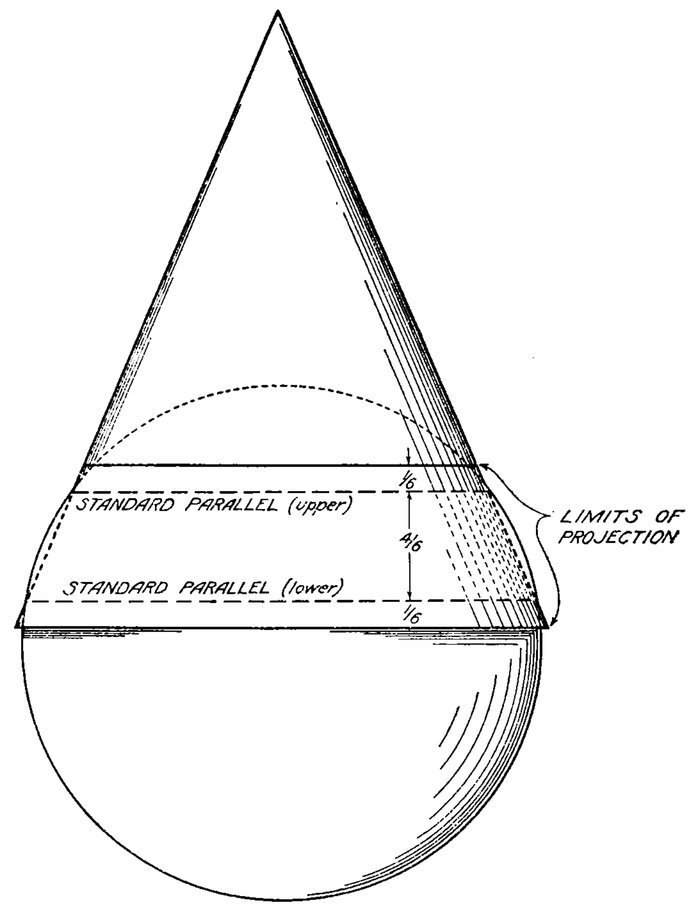

FIGURE 3.—Diagram showing the intersections of a cone and a sphere along two parallels of latitude. This diagram illustrates the principle of the Lambert conformal conic projection, but the projection cannot be constructed graphically by perspective projection; the standard parallels, furthermore, are not quite at the intersections.

charts, because the angular distortion in the latter is objectionable in plotting wind directions.

Lambert's conformal conic projection with two standard parallels is ideal for synoptic charts in middle latitudes.[8] The essential principle of the projection is illustrated in figure 3, which shows the intersections of a cone and a sphere along two parallels, although this projection (unlike the stereographic) is determined only analytically and not projectively, and hence is not completely represented by this figure: The earth is projected on the intersecting cone, but not perspectively; the parallels of latitude are concentric circles, and the meridians are radii of these circles. The scale varies with latitude, but is constant along parallels. The two selected parallels along which the scale is held at the standard value are practically, though not exactly, those at which the cone intersects. The

[8] This projection is used by the U. S. Weather Bureau for its Chart AB for airway service.

radius of the parallel of latitude ϕ on the map is $r = K \tan^l \frac{z}{2}$, where z is the isometric colatitude and K, l, are constants determined by the standard parallels and scale; the meridian of longitude λ intersects the prime meridian at the angle $l\lambda$. On the International Ellipsoid, with the meter as unit of length, and standard parallels at 30° and 60°, l=0.71569, log K=7.05758; neglecting the ellipticity of the earth, l=0.71557, log K=7.058297.

With standard parallels at 30° and 60° latitude, the extreme variation from the standard scale is less than 4 percent between 25° and 65° latitude. Some meteorological services in high latitudes (for example Norway and Sweden) find it necessary to extend the chart to or beyond 75° N., at which latitude the scale of the Lambert conformal conic projection is 116 percent of the scale at the standard parallel; nevertheless the advantages of conformality in synoptic charts justify the use of this projection for that purpose.

The Mercator projection, representing the globe on a tangent cylinder, is ideal for synoptic charts in the equatorial regions; it is conformal and, although the scale increases with latitude, the distortion of area is not objectionable when the charts are confined to tropical and subtropical regions. Mercator's projection is not a perspective projection, but is entirely determined analytically. The meridians are parallel straight lines, equally spaced at the equator, producing an east-west stretching which is proportional to the secant of the latitude; the north-south stretching is also varied in the same proportion, hence the map is conformal. The distance of the meridian of longitude λ from the prime meridian on the map is $c\lambda$, and the distance of the parallel of latitude ϕ from the equator is $c \log_e \cot z/2$, where c is determined by the standard parallel and scale. Prior to the Salzburg meeting, the majority of the members of the Commission on Projections for Meteorological Charts were in favor of 30° latitude for the standard scale of the Mercator projection for the equatorial regions. However, representatives of meteorological services in the equatorial zone expressed preference for the standard scale at 22½°. This parallel had previously been designated in a resolution passed by the Regional Commission which met in 1937 at Lusaka.[9] The effect of a change of the standard parallel of the Mercator chart from 30° to 22½° is one of scale only and therefore not important, since the conformal conic chart of middle latitudes and the Mercator chart of the equatorial zone cannot be made to coincide along the thirtieth parallel, even with the same scale there, except by rolling contact.

All of these projections (polar stereographic, Lambert conformal conic, and Mercator) have only rectilinear meridians and concentric circular parallels with their common center at the common intersection of the meridians (at infinity in the Mercator), and may therefore be extended indefinitely in longitude, reaching around the world and repeating any region if necessary; and, furthermore, it makes no difference what meridian is placed in the middle of the map—all geographical features remain unchanged. These are essential properties of projections for international use, because European countries, for example, may wish to have the central meridian of their synoptic charts at 15° E., while on North American charts the central meridian may be at 90° W. Thus the maps of different countries, when on the same projection and scale, may be simply superimposed or juxtaposed, and will fit together.

[9] International Meteorological Organization. Regional Commission No. 1 (Africa). Minutes of the first meeting held at Lusaka, the capital of northern Rhodesia, August 17 to 26, 1936, pp. 25, 26. Utrecht, 1937.

In the third resolution there is provision for the extension of charts on any of the three projections into regions beyond those specified in the second resolution. For example, if the region of chief interest lies in the equatorial zone, the Mercator projection should be used for the principal working chart but it may be extended into the temperate zone beyond 30° latitude if required, in order that the map may be continuous. The fact that the portion in higher latitudes is not on the projection specified for temperate zones is of little consequence, since more detailed charts are prepared for the temperate zones by meteorological bureaus there, using the projection appropriate to that zone.

The fourth resolution needs no explanation.

Four new scales are recommended in the fifth resolution: 1 : 1,000,000, 1 : 7,500,000, 1 : 15,000,000, and 1 : 40,000,000. The other scales named in this resolution were originally recommended in Resolution 34 at London, 1921, except the scale 1 : 30,000,000 which had not been recommended in any resolution prior to the Salzburg meeting but came into use as a result of Resolution 22 at Copenhagen, 1929.

The Commission on Projections for Meteorological Charts and the Commission on Synoptic Weather Information are in harmony in recommending the use of a scale of 1 : 10,000,000 for principal working charts whenever possible. One of the reasons is that the Symbols Subcommission has the responsibility of prescribing the station model, the symbols to be used, their arrangement, and the number of items for each station. It is evident that the work of this subcommission would be exceedingly difficult or even impossible if many different scales should be used. Specifications for a station model that would be practicable for a chart on a scale of 1 : 10,000,000 might be entirely impossible, for lack of space, on a chart with a scale of 1 : 15,000,000. The scale 1 : 7,500,000 is provided for bureaus which find it impossible to use the scale 1 : 10,000,000; however, the Symbols Subcommission has designed the full station model for use on charts with a scale of 1 : 10,000,000, and, in the resolution previously quoted, urges the use of that scale.

It is recommended in the sixth resolution that, as far as possible, the scales named in the fifth resolution be used in printed as well as manuscript (working) charts. A considerable variety of scales is provided, ranging from 1 : 1,000,000 to 1 : 40,000,000. This is a step toward uniformity in maps printed for general distribution. There are many advantages in uniformity of sizes of printed maps: Convenience in handling in central bureaus and libraries is one consideration. It is hoped that eventually the printed maps will be standardized so as to furnish the student with more convenient access to world data.

In the seventh resolution it is recommended that the name of the projection, and the scale at the standard parallel(s), be printed on the map. An indication of scales at different latitudes is also included, which can be accomplished by placing at the end of each parallel of latitude at 5° intervals the ratio of the scale at that parallel to the scale at the standard parallel. Table 1 gives these ratios for the three standard projections at 5° intervals of latitude on both a sphere and an ellipsoid. The resolutions do not explicitly specify the figure and size of the earth that are to be used in computing the projections, although a "sphere" is referred to in Resolutions II and VIII. Tables computed by Sverdrup for the Lambert projection are given in Bjerknes' paper [2] and have already been used by several countries; the figure of the earth on which they are based is not stated. For the purpose of meteorological charts, the inaccuracy of considering the earth as a sphere is unimportant, and the differences between different ellipsoids are negligible; but if an ellipsoid be used, presumably it should be the International Ellipsoid, on which table 1 has been computed.

TABLE 1.—*Scale variations*

Latitude	Mercator [1]		Lambert [2]		Stereographic [3]	
	Sphere	International ellipsoid	Sphere	International ellipsoid	Sphere	International ellipsoid
°						
0	0.924	0.924	1.283	1.281	1.932	1.860
5	.927	.928	1.210	1.208	1.777	1.712
10	.938	.938	1.149	1.148	1.590	1.586
15	.956	.957	1.099	1.098	1.482	1.480
20	.983	.983	1.058	1.058	1.390	1.388
25	1.019	1.019	1.025	1.025	1.312	1.310
30	1.067	1.066	1.000	1.000	1.244	1.243
35	1.128	1.127	.982	.982	1.186	1.185
40	1.206	1.205	.970	.970	1.136	1.136
45	1.307	1.305	.966	.966	1.093	1.093
50	1.437	1.435	.968	.969	1.057	1.057
55	1.611	1.608	.979	.979	1.026	1.026
60	1.848	1.844	1.000	1.000	1.000	1.000
65	2.186	2.181	1.033	1.033	.979	.979
70	2.701	2.694	1.084	1.083	.962	.962
75	3.570	3.560	1.162	1.162	.949	.949
80	5.320	5.306	1.293	1.292	.940	.940
85	10.600	10.570	1.566	1.564	.934	.936

[1] Standard parallel, 22½°.
[2] Standard parallels, 30° and 60°.
[3] Standard parallel, 60°.

The Commission suggested in the eighth resolution that equal-area charts be used for climatological purposes, i. e. maps in which the relative areas of different regions are correctly represented. These would include the azimuthal equal-area projection for the polar regions, the equal-area conic projection (Albers') for middle latitudes, and the cylindrical equal-area projection for the equatorial zone.

In middle latitudes it makes little difference for meteorological purposes whether the conic projection for 30° and 60° is conformal (Lambert) or equal-area (Albers). They are so nearly identical that it is difficult to differentiate by inspection. For this reason, the eighth resolution contains the words "when special charts for climatology are required." Some meteorologists expressed a desire to use (for climatological purposes in middle latitudes) the conformal projection already employed for synoptic purposes, rather than prepare a special map on an equal-area projection that differs so little. Scales were not specified.

The ninth resolution requires no explanation.

CONCLUSION

While much remains to be done before complete uniformity is attained in manuscript and printed charts for meteorological work, the Salzburg resolutions, if adhered to by all meteorological services, will result in marked progress in that direction.

A review of action in the International Meteorological Organization shows that at all stages there has been a decided preference for conformality and continuity as the outstanding properties of synoptic charts.

For climatology, projections of the same type as those recommended for synoptic charts are preferred, except that they should have true representation of area rather than conformality.

In the future we shall certainly find meteorological bureaus extending their charts to cover large portions of the earth's surface, and in all probability the beginnings of daily charts of the whole world. These developments will necessitate more extensive international exchanges of weather information and more intensive standardization in collection, distribution, and charting of the data. The Salzburg resolutions on projections and scales of charts provide a sound basis for future expansion.

ACKNOWLEDGMENTS

It is a pleasure to acknowledge the assistance of the members of the Commission on Projections for Meteorological Charts, and of officials of the United States Coast and Geodetic Survey,[10] in preparing the resolutions adopted at Salzburg; of the directors of weather services in providing specimen charts, and data on projections and scales in use in various countries; and of Edgar W. Woolard and Charles M. Lennahan in the preparation of the comments on the mathematical properties of the projections and the calculation of table 1.

[10] Readers desiring further information regarding the theory, construction, and properties of the projections are referred to the following:
Oscar S. Adams. A study of map projections in general, *U. S. C. & G. S. Spec. Pub. 60*, Washington, 1919. Charles H. Deetz and Oscar S. Adams. Elements of map projection, *U. S. C. & G. S. Spec. Pub. 68*, Washington, 1934.
Tables of the International Ellipsoid are contained in *U. S. C. & G. S. Spec. Pub. 200.*

REVIEW OF UNITED STATES WEATHER BUREAU SOLAR RADIATION INVESTIGATIONS

By IRVING F. HAND

[Weather Bureau, Washington, D. C., June 1937]

The purpose of this paper is to present a summary to date of the methods employed and the results obtained in the solar radiation investigations conducted by the Weather Bureau. Many data are here published for the first time, while several tables and charts that have previously appeared in the MONTHLY WEATHER REVIEW are revised and brought up to date. Numerous references to the literature are included, to enable readers who so desire to readily locate further details (a useful general bibliography of some of the earlier literature is given by Kimball, *Bull. Mt. Weath. Obs.*, 3: 118–126, 1910).

INTRODUCTION

Radiation from the sun is the ultimate source of all except a practically negligible portion of the continual supply of energy that is essential for the maintenance of plant and animal life on the earth and for the operation of nearly all natural phenomena on the surface of the earth; in particular, the amount and the distribution in time and space of the solar radiation which is intercepted by the earth is the primary generating cause of the physical activities in the atmosphere that determine weather and climate. The study of the radiation from the sun is therefore of direct and fundamental importance to numerous different fields of both pure and applied science, including meteorology.

The Weather Bureau first began to devote attention to solar radiation measurements in 1901. (See *Rept. of the Chief of the Weather Bureau*, 1901–1902, p. xvii; and C. F. Marvin, MO. WEA. REV., 29: 454–458, 1901.) In July of